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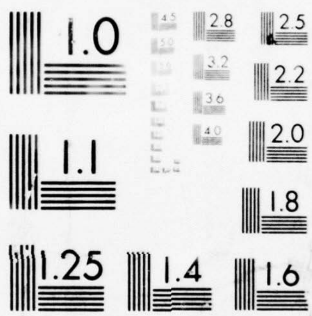

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THE SAN FRANCISCO BAY - DELTA
WASTEWATER AND RESIDUAL SOLIDS
MANAGEMENT STUDY.

VOLUME VI.

Technical Appendix.

THE PUBLIC HEALTH IMPLICATIONS OF
LAND APPLICATION OF WASTEWATER
AND RESIDUAL SOLIDS.

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THE PUBLIC HEALTH IMPLICATIONS OF PROPOSED WASTEWATER DISPOSAL AT EIGHT SELECTED SITES IN THE SAN FRANCISCO BAY - DELTA AREA

A Report for P.B.Q. & D., Inc.

The Sequoia Group

Berkeley, California

January 1973

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REPORT ON THE PUBLIC HEALTH IMPLICATIONS OF PROPOSED WASTEWATER DISPOSAL AT EIGHT SELECTED SITES IN THE SAN FRANCISCO BAY-DELTA AREA

I. Introduction

The purpose of this report is to assist the U.S. Army Corps of Engineers, San Francisco District, in the evaluation of the sites for the disposal of wastewater estimated to be generated by twelve Bay Area counties in the near future. The extent of this report is confined to the Public Health aspects of wastewater disposal at ~~the~~ eight selected sites. Shown in Plate A., (p. 3).

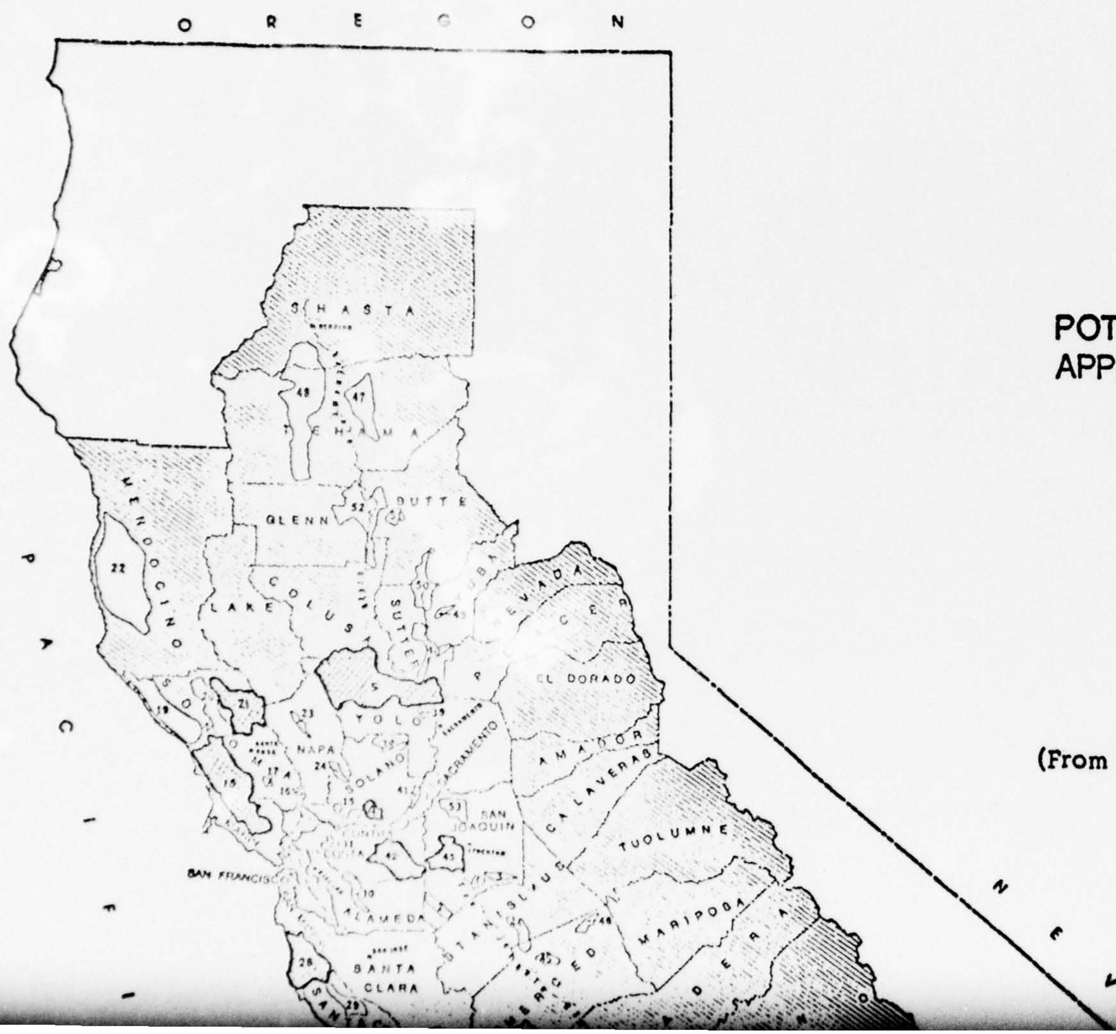
It is to the Corps of Engineers' credit that they have the foresight to consider the impact of these proposed activities upon human health as well as upon nature in general. The assessment of the public health implications of many engineering activities is fraught with difficulties. Often the data required for such assessment is not attainable and more often the data gatherers are not aware of the type of information needed for adequate health projections. The approach used in this report is to evaluate the probable changes in public health aspects due to wastewater application to the eight selected sites. We believe the probability matrix technique used is novel in the area of assessing public health impacts of wastewater management.

The evaluation to follow is based upon data presently available in the P.B.Q. & D., Inc. report "The San Francisco Bay-Delta Waste Water and Residual Solids Management Study," Vols. I through V., hereafter referred to as "the Report." The results of the public health assessment herein presented are obviously dependent upon the adequacy of the

available data. In many instances the kind of information required was not available and therefore the accuracy of the assessment is affected accordingly. Even though all the desired data is not now available, the questions to be answered in future evaluations when considering actual waste disposal operations have been pointed out.

Plate A

POTENTIAL WASTEWATER APPLICATION SITE MAP

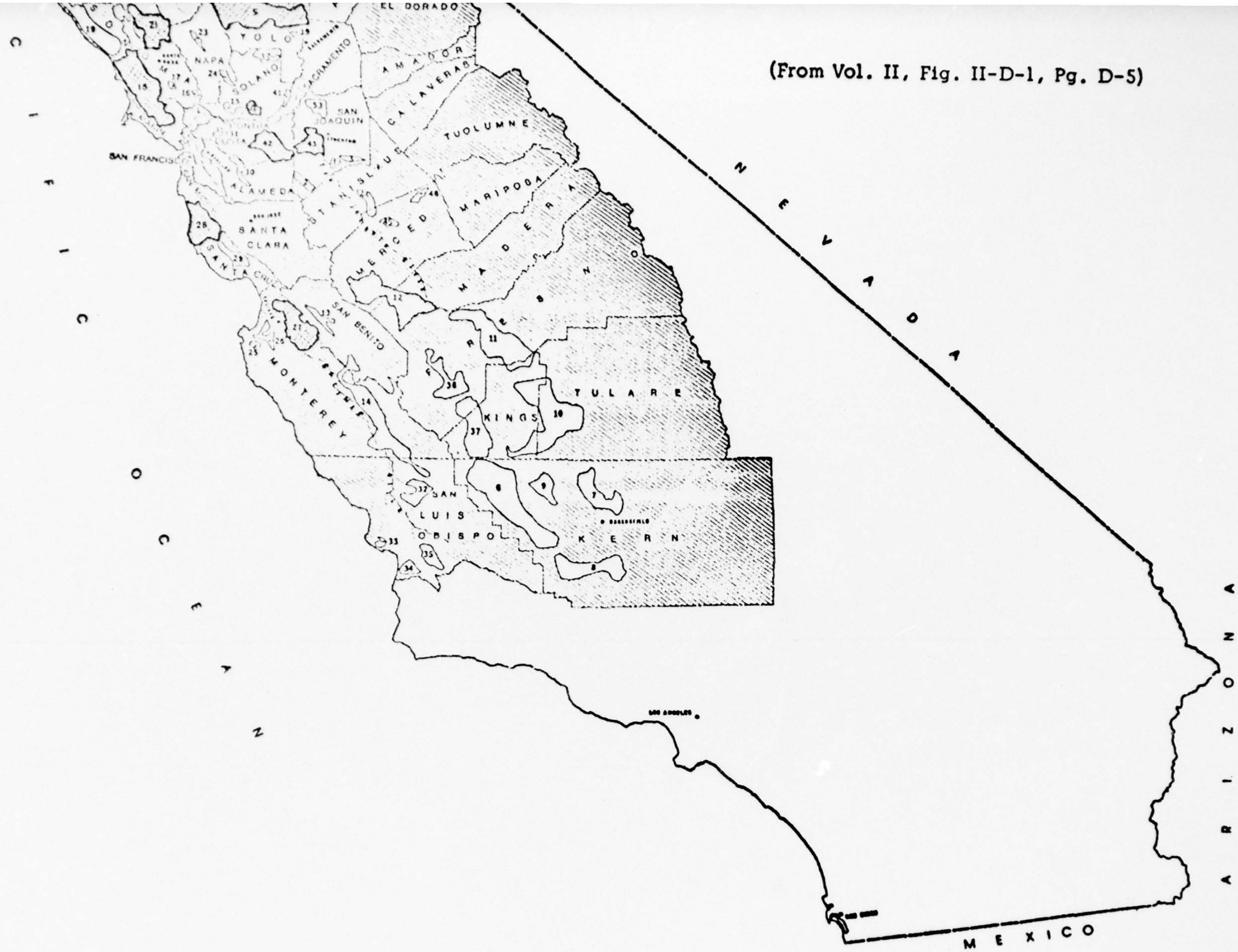


LEGEND

- STUDY AREA
- IDENTIFIED SITES
- SELECTED SITES

(From Vol. II, Fig. II-D-1, Pg. D-5)

(From Vol. II, Fig. II-D-1, Pg. D-5)



II. Methods

In evaluating the probable public health changes at the selected sites, our approach has been to rank order the eight sites being studied according to the expected magnitude of the public health problems that could result from wastewater disposal. We have represented the expected magnitude of public health problems at a site as:

$$s_i = \frac{\sum_{j=1}^{n} P_{ij} \; s_j}{\sum_{j=1}^{n} s_j}$$

where s_i is the expected magnitude at site i

P_{ij} is the subjective probability that site i will have public health problem j $(0 \leq P_{ij} \leq 1)$

s_j is a physician's opinion of the relative severity of problem j $(0 \leq s_j \leq 100)$

n is the number of public health problems being evaluated.

The P_{ij} are subjective probabilities, but represent the public health consultants' best judgments of the probability that a problem will occur given the current state of knowledge.

The s_j were obtained from a physician. They are only relative values since the judgments of severity of a problem were made in comparison to the other problems being studied, not to some absolute level of severity. These judgments were separated from the probability estimates because severity represents a medical opinion. The physician made his judgments based on his knowledge of the life expectancy, degree of disability, and effectiveness of treatment of the public health problems considered.

The method that was used to arrive at the rank order of sites and degree of public health severity was as follows:

1. Public health consultants (a microbiologist, a virologist, a medical microbiologist, and a toxicologist) identified the public health problems that have some chance of occurring when disposing of wastewater as proposed in the Report.

2. The public health problems were subdivided into five major categories under the headings of "Infectious and Non-infectious Diseases." The consultants considering these problems were selected for their expertise in one or more of these categories.

A public health problem was defined to exist if the incidence of the disease would increase above its current level to the degree that action by a public health agency would be indicated. Thus, there would be no rabies problem, as an example, as long as there continued to be the same number of rabies cases as before the disposing of wastewater. This definition of a problem is appropriate when attempting to assess the impact of wastewater disposal at a site. It would have no impact if the incidence of a disease did not change. The problems which were evaluated and their relationship to each other is shown in Figure I, p. 6.

Appendix I has a brief explanation of why and how each problem could occur by disposing of wastewater.

3. Each consultant specified the information that he would need about a site and the wastewater applied in order to estimate the probability that a specific public health problem would occur.

A questionnaire was filled out by each expert for each problem he evaluated. A copy of this questionnaire is included in Appendix II.

FIGURE 1

PUBLIC HEALTH PROBLEMS

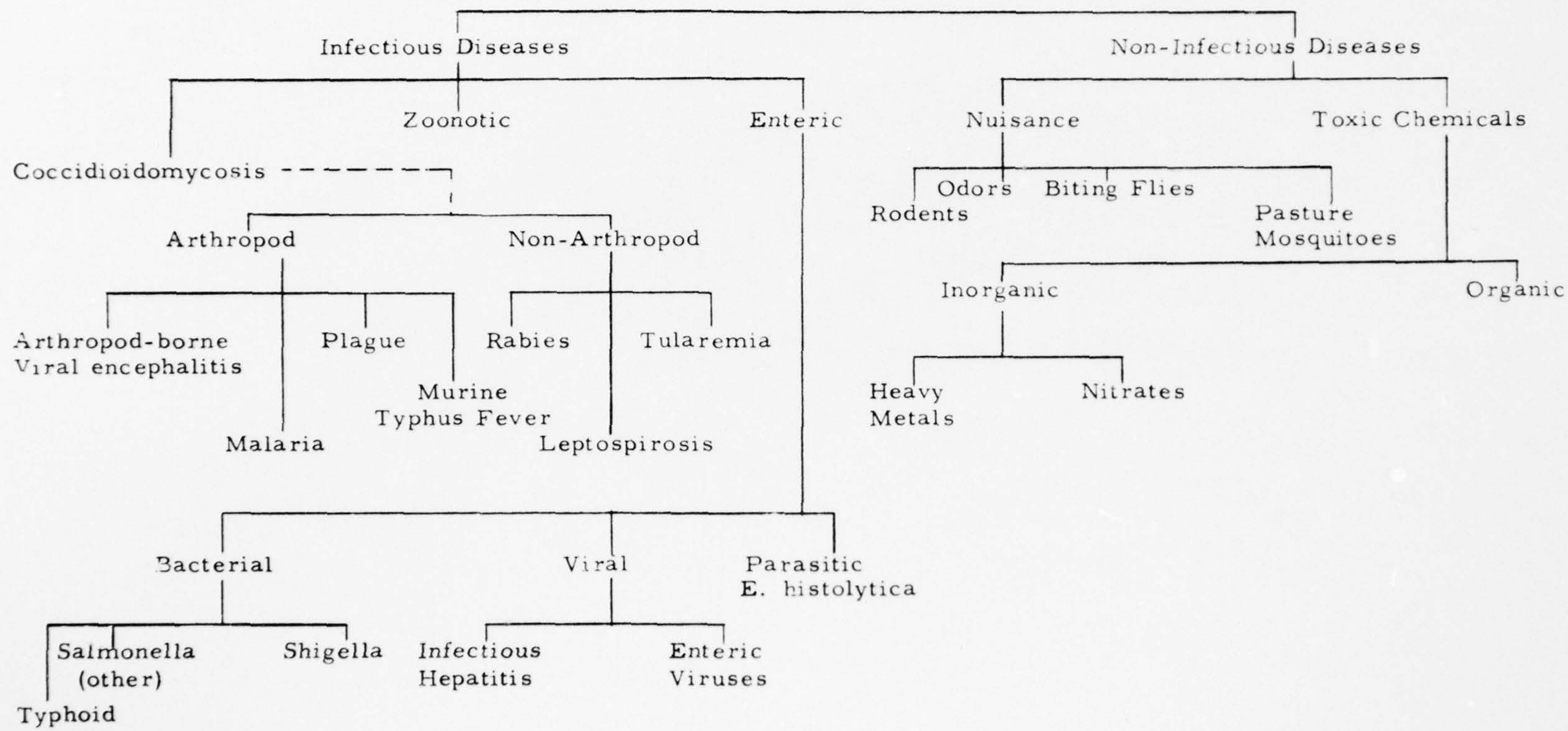


FIGURE 1. Identification of Public Health Problems

In general, the experts needed to know the concentration and dose of the agent causing the public health problem, the size of the population that might be exposed to the agent and how the population would contact it, the method of treatment of the water and the method of treatment of residual solid waste and the method of application.

The requested information that was available was extracted from the five volumes of the Report and summarized by site for each public health problem. In some cases not all of the needed information was available. The consultant writing for each public health problem area indicated when information was lacking that he felt was important to his decision making. Before deciding to dispose of wastewater at a given site, this missing information should be obtained and used to update the experts' estimates of probability.

It will be observed that the presentation of material in Appendix I varies from consultant to consultant. Since scientists differ in their approach to considering a problem, this result was to be expected. It is believed, however, that this variety in method will not interfere with the clarity of their statements.

4. To obtain an expert's subjective probability, P_{ij}, that public health problem j would occur at site i, each site was described, using the information requested. The consultant was then asked to arrange the descriptions in the order of highest probability to lowest probability that the public health problem would occur. He was then asked to mark on a horizontal 100 millimeter line with a range of 0 to 1 the probability that each site would have the problem. An example of the form used is in Appendix II.

To make sure that all four experts were using similar reasoning in making their estimates, two problems which all four experts understood, one of which had a high probability and the other a low probability, were discussed and marked on the horizontal lines in the same location for all four experts. In addition, a half hour training session preceded the estimation. The meaning of a probability of 0 and 1 were discussed, as well as the probability of the two problems used to anchor their estimates.

To obtain a number for the probabilities, P_{ij} , the distance from the 0 end of the line to the mark on the line was measured in millimeters.

5. Although the probability of a public health problem may be high, the relative severity of the problem may be low, from the standpoint of life expectancy, degree of disability, and extent of treatability. Pasture mosquitoes as a nuisance is an example of a public health problem that has low severity but high probability. Likewise, a problem may have a high severity, like rabies, but low probability. Whether it is preferable to dispose of wastewater at a site where there is a high probability of rabies but low probability of mosquitoes, or at a site where there is a high probability of mosquitoes but a low probability of rabies, requires a medical judgment that mosquitoes are more or less preferable than rabies. Although this example seems obvious, the choice is not as clear when comparing infectious hepatitis to arthropod-borne viral encephalitis.

6. In order to obtain order of relative severity, a public health physician considered the problems. He first rank ordered the problems and then scaled their severity on a 100 millimeter horizontal line as shown in Appendix II . To achieve the latter, he marked the most severe problem, rabies, and one of the least severe odors. He then marked the

remaining problems between these two end points. Rabies was arbitrarily assigned a value of 100 and odors a value of 0. The distance along the line was measured in millimeters to obtain the values for the other problems.

7. The overall assessment of the expected magnitude, S_i, of public health problems at each site was obtained by multiplying the probability that each problem would occur, P_{ij}, times the severity of the problem, s_j, summed across all problems.

The results are shown in Table I, where s_j denotes the relative severity of problem j. Since we were only interested in rank ordering the sites relative to each other, the numbers 0 and 100 could be arbitrarily assigned odors and rabies. If any other numbers were assigned, the rank order of the sites would come out the same.

This approach has resulted in several benefits.

a. The rank order of the sites provides an indication of which site is best suited for disposing of wastewater from a public health standpoint.

b. It provides for combining several technical opinions and separating probabilities of occurrence from severity of problems.

c. The list of information that the experts need to make a judgment about the probability that each public health problem will occur provides a basis for future data to be collected about each site, or for future experiments to be conducted at each site. Although the Report provides much of the needed information, some was not available and is so indicated.

d. How the experts arrived at their judgments is made explicit. The information they used and the number they assigned (the probability) is recorded for the decision makers' review. One might disagree with an expert's opinion, but at least the disagreement can be made explicit and some resolution made. Examples of resolutions are:

1) agree to disagree and see if the decision is any different,

2) compromise, or

3) conduct further study.

For the most accurate probabilities to be assigned to each site, all of the requested information should be considered. To the degree that this information was lacking, the consultant was hampered in arriving at probabilities.

III. Assumptions

In making the assessment of the probability of a problem's occurring on any of the selected sites upon the discharge of wastewater, a number of general assumptions were made. These assumptions are:

1. That all water applied to the land has undergone secondary treatment and disinfection by chlorination or equivalent.

2. The infectious agent concentration for the wastewater was calculated by assuming that the number of coliforms present is related to the number of infectious microorganisms present and that this ratio is a function of the current reported incidence of enteric diseases in California.[1] Assuming 1×10^7 coliforms per 100 ml of raw waste to be treated, assuming 99% removal during primary and secondary treatment and assuming 99% removal by disinfection (chlorination),[2] then the following would be expected:

	Number of Organisms Present after Treatment	
Organism	With Chlorination **	Through Soil *
Coliform	1×10^3/100 ml	10/100 ml
Salmonella & Shigella	2.5/100 ml	0.025/100 ml
Viruses	0.1/100 ml	0.001/100 ml

* Assumes 99% removal of organisms applied.

** "Water Supply and Wastewater Disposal," Fair and Geyer, John Wiley & Sons, Inc., 1954.

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1 The assumed relationship between coliform and enteric bacterial pathogens is the same as described by Kehr and Butterfield (1943) Pub. Hlth. Dept: 58:589. And in this instance is based upon a California Salmonella reporting rate of 10 cases/100,000 population (Approx. 25 Salmonella/Shigella per 1×10^6 coliforms).

2 Kabler, P. W. (1959) Sewage and Industrial Wastes, Vol. 31, p. 1373.

3. All forest and pasture will be spray irrigated, crops will receive mixed surface and spray irrigation and marshes (rapid infiltration areas) will receive surface application.

4. Organic sludge concentration was estimated (as per Report, Vol. III, Table III B-2) as 1000 to 3000 pounds per million gallons of wastewater and that after treatment (settling and digestion) the amount would be equivalent to between 250 and 750 pounds per million gallons of wastewater collected. It was assumed that this treated sludge material would be remixed with the treated wastewater and the total applied to the appropriate acreage. This would be approximately equivalent to between 28 and 84 mg/l of solids in the applied return water. Based on application rates of Alternative One of the Report, at each site this would approximate about a thousand pounds per acre per year (Ranged from 874 to 1165 lbs. per acre/year).

5. The impact of aerosol generation caused by spray irrigation was not considered in this report. It was the consensus of the public health consultants that this would not be a significant route for the transmission of infectious disease agents which might be present in the water applied. This consensus was based upon the lack of evidence that this has been a hazardous procedure when practiced. In particular, the lack of increased disease morbidity among secondary sewage plant operators who are continuously exposed to fine aerosols generated from water of poorer quality than that proposed to be applied to the selected sites would tend to bear this out. The provision for buffer zones around periphery of spray irrigated plots is a safety precaution. Spray irrigation with wastewater should have no discernible effect upon air pollution levels.

IV. Results

The overall results of this study are shown in Table I (p. 14).

The rank order of the sites according to the least probable magnitude of public health problems, or most preferred sites for applying wastewater, are as follows:

Rank Order	Site Number
1	4
2	42
3	28
4	43
5	21
6	27
7	5
8	18

S_i in Table I indicates the probable magnitude on a scale of 0 to 1.0 of combined public health problems at each site. The value of S_i is computed according to the equation given on page 4. If the S_i are plotted on a line to represent the distance from 0, the following is obtained:

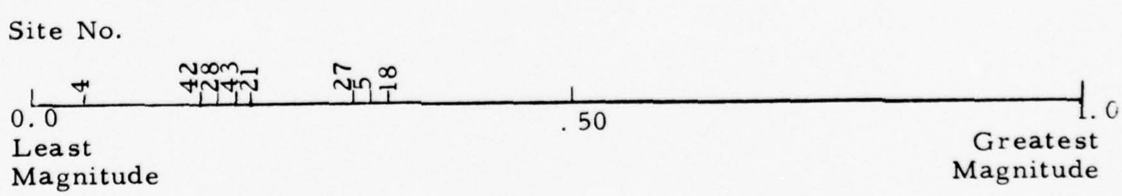

TABLE I

ASSESSMENT OF EXPECTED MAGNITUDE OF PUBLIC HEALTH PROBLEMS BY SITE

Problem	rabies	enteric virus polio	plague	coccidioidomycosis (blacks)	infectious hepatitis	encephalitis	typhoid	heavy metal effects: lead and zinc/cadmium	murine typhus fever	other salmonella	parasitical: e. hystolytica	coccidioidomycosis (whites)	shigella	nitrates effect	malaria	tularemia	leptospirosis	nuisance: pasture mosquitoes	enteric virus: adeno	nuisance: biting flies	enteric virus: echo	nuisance: rodents	nuisance: odors	
S_j	100	100	87	63	63	52	49	47	42	39	33	24	21	20	17	15	14	7	4	4	0	0	0	
Site	P_{ij}																							S_i
4	.03	.04	.04	.00	.04	.26	.04	.00	.04	.04	.02	.00	.05	.00	.02	.04	.07	.48	.04	.48	.04	.03	.00	.05
5	.25	.08	.23	.98	.09	.98	.08	.21	.04	.08	.02	.98	.08	.00	.20	.75	.47	.99	.08	.99	.08	.73	.00	.32
18	.74	.35	.50	.00	.36	.50	.34	.26	.04	.37	.02	.00	.20	.26	.02	.20	.23	.99	.35	.99	.35	.47	.00	.34
21	.50	.04	.50	.00	.03	.74	.03	.04	.04	.04	.02	.00	.04	.18	.02	.75	.45	.99	.04	.99	.04	.48	.00	.21
27	.50	.03	.49	.84	.03	.50	.03	.11	.04	.03	.02	.84	.03	.05	.02	.50	.45	.99	.03	.99	.03	.75	.00	.30
28	.51	.03	.48	.00	.03	.21	.03	.26	.04	.03	.02	.00	.03	.19	.02	.03	.05	.99	.03	.99	.03	.48	.00	.17
42	.20	.03	.20	.16	.04	.74	.03	.20	.04	.03	.02	.16	.03	.13	.02	.48	.05	.99	.03	.99	.03	.48	.00	.16
43	.19	.04	.20	.16	.04	.95	.03	.26	.04	.04	.02	.16	.04	.26	.20	.71	.20	.99	.04	.99	.04	.76	.00	.19

Note: S_j = severity of problem (medical); P_{ij} = probability of occurrence of problem;
S_i = magnitude of public health problem. See Appendix I for problem descriptions.

There are three apparent groups of sites. The first group contains Site 4 only, which is the most suitable site from a public health standpoint to apply wastewater. The second group includes Sites 28, 42, 43, and 21 which are the next most suitable sites. The third group includes sites 27, 5, and 18, which are the least suitable sites.

Although site 18 is the least suitable site of the eight, its expected combined magnitude is only 0. 33. It would appear, therefore, that this site could be used to apply wastewater.

The three groupings occurred primarily because of the potential incidence of Coccidioidomycosis in Sites 5 and 27, and the potential for the more severe Zoonotic diseases of encephalitis and plague in all areas. In these latter instances, there were a good number of sites in which the probability of a problem rising above the present level was registered as 0. 50. This, of course, multiplied by the severity of these diseases, has a relatively large impact upon the overall evaluation of a site. It should be understood that a probability of 0. 5 means that there is as much probability that there will be a problem as that there <u>will not</u> be a problem.

It is readily apparent that there are two areas of public health concern in the application of waste water to the land. One is the hazard imposed by the presence of toxic or infectious agents in the wastewater applied and the second is the impact of such application upon the level of animal population present in the area with consequent increase in Zoonotic diseases. The former problem can be controlled rather effectively by treatment of the wastewater to the degree assumed in this report It would be for this reason, primarily, that the impact of infectious enteric disease upon the site rankings was minimal. The control over

the increase in those animal or insect populations that are also vectors or reservoirs of disease transmissible to humans is less certain than the control of enteric diseases. For this reason, the site rankings were affected for the most part by the probability of occurrence of Zoonotic disease problems.

Of all the problem areas evaluated in the context of this report, the toxic chemicals are assessed with the least accuracy. Because of the lack of specific information concerning the kinds and concentration of chemicals at critical points in the distribution system, the potential of a long term (chronic) and accumulative response exists. A cause and effect relationship is most difficult to establish in chronic diseases.

The overall impact of applying wastewater to any of the sites studied would be moderate with well conceived and carefully executed water management techniques. These techniques would have to be specific to the project design of each site. Pilot studies in representative areas will be most helpful in determining specific safeguards for maintaining the highest public health levels.

This volume of the report was prepared

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APPENDIX I

PUBLIC HEALTH PROBLEMS THAT COULD BE EXACERBATED OR CREATED BY APPLICATION OF WASTE WATER TO THE LAND

Major Problem Areas:

I. Infectious Diseases - Coccidioidomycosis

II. Infectious Diseases - Zoonotic, and
Non-Infectious Diseases - Nuisance

III. Infectious Diseases - Enteric

IV. Non-Infectious Diseases - Toxic Chemicals

APPENDIX I

I. MAJOR PROBLEM AREA
INFECTIOUS DISEASES - COCCIDIOIDOMYCOSIS

Coccidioidomycosis is an infection of humans and other animals which is usually acquired by inhalation of spores of the fungus Coccidioides immitis. This fungus resides in the soil in several areas in California (as well as elsewhere in the southwest). Infections occur predominantly during the dry dusty season of the year, summer and fall, and the incidence diminishes during the rainy season. Thus, reduction of dust by wetting or oiling soil (roads), or planting grass can reduce the incidence of the infection. On the other hand, movement of soil, as during excavation, with creation of dust can increase the occurrence of infections. Heavy winter rainfall is followed by increased incidence of the disease during the following dry season. Thus, waste water reservoirs may provide wet soil for increased growth of the fungus and increased spores contributing to increased infection. If water level is maintained at high level and no drying occurs, the fungus will not be likely to become airborne. If water level falls allowing drying, fungus spores can become airborne and increase incidence of infection.

Although white and black peoples have a similar susceptibility to coccidioidomycosis, the latter have a higher frequency of (very severe) disease. For this reason, it is important to know the racial composition of the susceptible community involved. Since this information was not available for the purposes of this report it was assumed that racial distribution was the same at each site.

INFORMATION NEEDED TO MAKE
PROBABILITY ESTIMATES FOR PUBLIC HEALTH
PROBLEM: COCCIDIOIDOMYCOSIS

1. Incidence of coccidioidomycosis in areas at present.

2. Present population.

   Age, mobility, recent changes, anticipated influx distribution.

3. Are animals in area infected (sentinel animals).

   Are there rodents present in area?

4. Extent of excavation -

   Dikes to be built up; pits to be dug; will wetting of soil be carried out?

5. Will roads be oiled?

   How will maintenance of disposal sites be carried out, i.e., will trucks be moving on roads?

6. Will grass be planted?

7. Is ground to be kept wet or will pits be drained dry?

8. Extent of rainfall, duration of wet season -

   Any creeks or rivers in area?

TABLE II. INFORMATION LIST

Infectious Diseases - Coccidioidomycosis

SITE	Incidence of Disease	County Population	Percent Less Than 18 Years	Projection Recent Changes in Population	Dist. of Population Near Site	Animals Infected Rodents Present	Excavation Dikes-Pits Wetting of Soil
5	Present	93,800	32				Yes
27	Present	250,071	33				Yes
42	Present	579,000	35				Yes
43	Present	297,700	33				Yes
28	Absent	556,800	32	Not Available	Not Available	Not Available	Yes
4	Absent	169,941	35				Yes
18	Absent	207,200	32				Yes
21	Absent	213,000	32				Yes

2

ION LIST

oidomycosis

t. of opu- tion ar Site	Animals Infected Rodents Present	Excavation Dikes-Pits Wetting of Soil	Workers Have Air-Conditioning	Paved or Oiled Roads	Wet and Dry Reservoirs	Grass to be Planted	Average Annual Rainfall in Inches
		Yes	No	Yes	Yes	Yes	18
		Yes	No	Yes	Yes	Yes	16
		Yes	No	Yes	Yes	Yes	16
		Yes	No	Yes	Yes	Yes	11
Not Available	Not Available	Yes	No	Yes	Yes	Yes	38
		Yes	No	Yes	Yes	Yes	17
		Yes	No	Yes	Yes	Yes	37
		Yes	No	Yes	Yes	Yes	52

II. MAJOR PROBLEM AREAS
INFECTIOUS DISEASES - ZOONOTIC
NON-INFECTIOUS DISEASES - NUISANCE

A. Zoonotic Diseases

1. General factors

These include many natural parasites of wildlife that can be transmitted tangentially to man and usually produce disease in man because he is the aberrant or unnatural host. Man becomes involved in these diseases either when he enters an endemic area or when he exacerbates the problems through his agricultural practices, thus creating conditions that allow production of abnormal vector and/or vertebrate populations. Some of the data that will be necessary to adequately assess the impact that wastewater application will have on zoonotic diseases are summarized in Table III. Additional information is needed.

a. *Human populations at risk*

There will be no public health problem unless exposure of humans occurs. At present, it is difficult to determine the human risk factor because there is insufficient information available in the Report on future resident population, public access and recreational development to be permitted within each site. Information on human populations immediately outside the sites is also of importance because vectors and vertebrates infected at the site could migrate to adjacent areas.

b. Occurrence of zoonotic diseases at each study site

Information should be gathered to document the occurrence of zoonotic diseases within each study site. This information is probably available through county or state health agencies.

c. Vertebrate populations

Information on species composition of vertebrate populations at each site is available but there is no information on relative abundance except those species that are taken by hunters. Additional surveys of birds should be made during the nesting season to obtain information on resident species, primarily house finches, house sparrows, blackbirds and mourning doves, which are important hosts of arthropod-borne viral encephalitides.

d. Blood-sucking arthropod populations

No information is provided in the Report on what species of blood-sucking arthropods, primarily mosquitoes and gnats, occur at each of the proposed sites nor is there information on whether these sites are located within established mosquito abatement districts.

e. Proposed use of land

Information on general land use is available but there is no way that accurate estimates can be made regarding increases in specific land uses over what currently exists at each site. Such information is important for irrigated pastures and marshlands to accurately assess breeding of mosquitoes and gnats.

2. Specific Diseases

a. Arthropod-borne viral encephalitides

There are three different viruses in California that are transmitted by mosquitoes and that produce encephalitis in man. These are western equine encephalomyelitis (W.E.E.), St. Louis encephalitis (S.L.E.) and California encephalitis (E.). WEE virus also produces encephalitis in horses and tree squirrels.

The ecology of these viruses is extremely complex because one must consider the interactions between at least four factors, i. e., the virus, vertebrate host, mosquito and environment. The endemic cycles of WEE and SLE viruses involve wild birds, primarily passerine birds, as the vertebrate hosts and Culex tarsalis as the vector. During periods of peak transmission, chickens, pheasants, and jackrabbits serve as secondary vertebrate hosts of WEE and SLE viruses. CE virus involves jackrabbits and tree squirrels as vertebrate hosts and Aedes melanimon as the vector.

In assessing the impact that wastewater land application will have on arthropod-borne virus encephalitides at each site, one must consider primarily increases in mosquito breeding habitat (i. e., irrigated pastures and marshlands), summer temperatures, available nesting sites for birds, and vertebrate species. One can expect increases in encephalitis primarily at those sites that are in the Central Valley because of longer breeding seasons and higher temperatures. CE virus activity will probably increase at sites within the Coast Range. (See Figure 2)

b. Plague, Murine Typhus Fever, Tularemia, Leptospirosis, and Rabies

With the exception of murine typhus fever, all of the above diseases are known to occur at or in the vicinity of the proposed sites for wastewater land application. The important factor in all of these diseases is vertebrate host populations. There is no question but there will be increases in most important vertebrate

host species of disease, but it is impossible at this time to predict how soon this will take place and to what extent. High humidity in these areas will cause initial migration of some rodent species from the site and other species will take their place. Additional pasture, grain crops, and alfalfa will allow a build-up in ground squirrel and jackrabbits, which in turn will provide more food for carnivores. Populations of carnivores will be highest where vegetation is dense enough to provide adequate shelter. The basic cycles of each of the above diseases is depicted in Figures 3, 4, 5, 6, and 7.

Figure 2. Arthropod-Borne Viral Encephalitides

Western Equine Encephalomyelitis (WEE)
St. Louis Encephalitis (SLE)
California Encephalitis (CE)

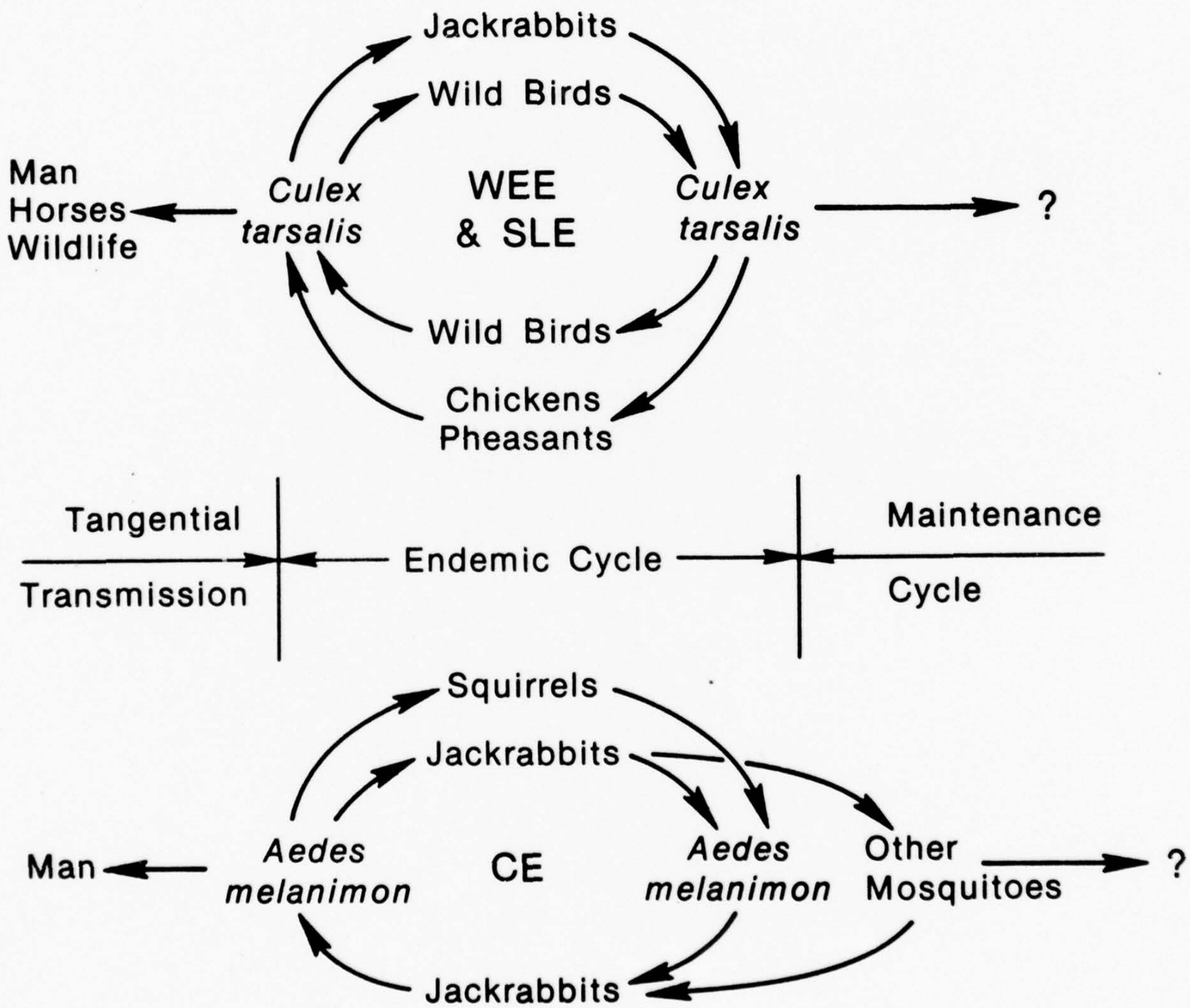


Figure 3. Plague (*Yersinia pestis*)

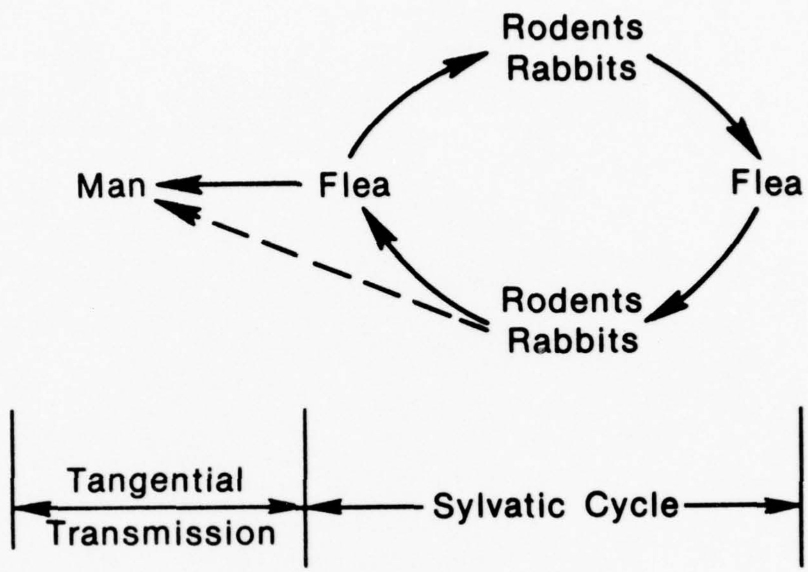


Figure 4. Murine Typhus Fever (*Rickettsia mooseri*)

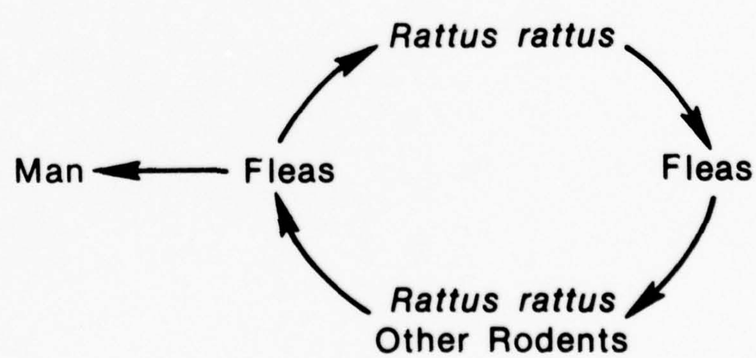


Figure 5. Tularemia (*Francisella tularensis*)

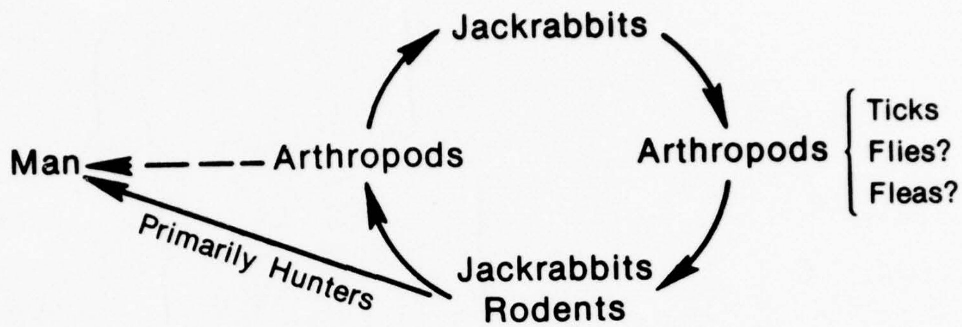


Figure 6. Leptospirosis

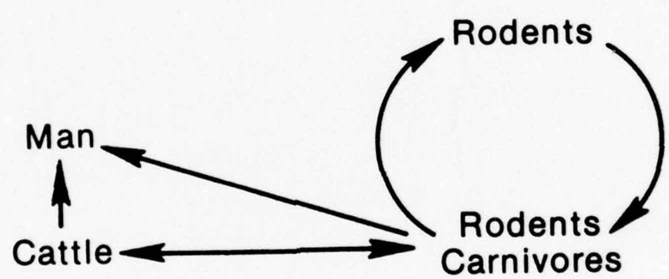
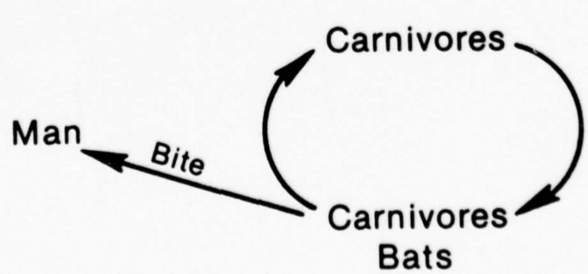


Figure 7. Rabies



B. Human Malaria

Although human malaria was historically an important public health problem in California, it has been eradicated from California for over thirty years, except for a small outbreak that occurred in 1952. However, the vector mosquito (Anopheles sp.) is still present in California and malaria is always a potential threat if an infected man should enter an area where there is a high vector population.

Anopheles breeds primarily in rice fields so the only site that might contribute to the malaria problem would be site 5. However, the planned acreage of rice for site 5 is small in comparison to acreage of rice in areas immediately north and east of this area.

C. Nuisance (Pest Problems)

As previously stated, there is no question but that there will be an increase in certain pests such as biting flies, pasture mosquitoes (Aedes nigramaculis) and rodents. There are a number of means available to control rodents so they should not be a problem. The mosquito problem would be difficult to control. As a control method, mosquito fish can be used in ponds and marsh areas. However, there is no effective means of controlling pasture mosquitoes in California today because they are resistant to all licensed insecticides. Thus, any person involved in mosquito abatement would advise against irrigated pastures at any of the proposed sites. If irrigated pastures are used, then proper drainage should be ensured and the land should not be used for grazing because the hoofprints will then allow mosquito breeding.

INFORMATION NEEDED

INFECTIOUS DISEASE - ZOONOTIC
NON-INFECTIOUS DISEASE - NUISANCES

1. Human populations at risk

   a. Resident populations (urban and rural)

   b. Immigration resulting from increased agricultural lands

   c. Excursions into site for recreational purposes

2. Domestic mammal populations, primarily horses

3. Hematophagous arthropod populations, primarily mosquitoes

   a. Acres of breeding sites (current and projected)

      1) irrigated pastures

      2) rice fields

      3) marsh lands

   b. Control

      1) water management

         a) type of holding ponds

         b) type of irrigation

         c) recycling excess irrigation water

         d) grazing of livestock in recently irrigated areas

         e) water drainage

      2) mosquito abatement

         a) biological

         b) chemical

c. Prevailing winds that would result in movement of mosquitoes into areas of dense human populations

4. Vertebrate populations

a. Avian fauna

1) species (resident, migratory)

2) relative seasonal population densities

3) nesting areas

a) sloughs

b) thickets

c) tules

d) deciduous trees

e) orchards

f) groves

b. Small mammals (rodents and lagomorphs)

1) species

2) relative population densities

3) food sources

a) grain crops

b) alfalfa

4) breeding sites and ground cover

a) weed-covered ditches

b) fence rows

c) thickets

d) forests

c. Wild carnivores

1) species

2) food sources

a) birds

b) small mammals

3) ground cover

5. General geographical areas

a. Coastal

b. Coastal inland valley

c. Central valley - rural agricultural

d. Delta areas

6. Water temperatures

The following are questions which cannot be answered with available information but which may have general impacts on future public health problems in each site.

Will there be an increase in human and domestic animal populations as a result of the projected agricultural usage of the land?

Will there be an increase in water available for agricultural purposes over what currently exists in these areas or will the water that is currently available in these areas be merely supplanted by water from sewage effluent?

What plans are being made for water management at each site to avoid the creation of suitable breeding sites for invertebrates and vertebrates? (i.e., holding ponds, recycling of excess water used in flood irrigation, grazing of livestock in only dry pastures, proper leveling of pasture areas to promote rapid drainage, etc.)

Are the sites to be included in new or established mosquito abatement districts?

TABLE III. INFORMATION LIST
Infectious Disease - Zoonotic
Non-Infectious Disease - Nuisance

SITE	Geomorphic Province	Temperature (Average July °F)	Human Populations at risk [a] Resident	Recreation Visitor Days(x10⁶)[b]	Non-Hunting (Man Days)	Hunting (Man Days)	Land use not including Exclud… Total Net Area	Forest	Irrigated Pasture	Marsh
4	Within Coast Range	69	---	28.122	14,768	23,986	---	---	---	---
5	Eastern slope of Coast Range and Central Valley	72-77	93,800	109.37	12,000-30,000	46,500	304.8	68.5	72.1	70.6
18	Western slope of Coast Range	56-60	207,200	254.27	78,800	42,900	185.1	37.7	122.9	7.8
21	Within Coast Range	64-68	213,000	105.35	25,000-50,000	30,100	108.2	37.5	45.2	24.6
27	Within Coast Range (Salinas Valley)	68-74	---	120.59	---	---	99.4	22.9	43.2	22.6
28	Western slope of Coast Range	58-64	556,800	109.38	4,900	6,000	114.6	91.3	16.1	---
42	Central Valley Inner Coast Range	72	570,900	266.06	---	26,200	57.0	14.0	58.5	---
43	Central Valley -Sacramento San Joaquin Delta	72-74	297,700	265.68	---	49,800	99.4	---	7.3	9.7

Summary of data from each study site that is currently available to evaluate the impact of wastewater land application on Zoonotic diseases, malaria and pest problems.

a. No specific information available for each site but rather for total county in 1970-71.

b. Gross recreational user potential.

Land use not including Excluded Area (Acres x 10^3)							Wildlife [c]					
orest	Irrigated Pasture	Marsh	Alfalfa	Rice	Grain	Orchard	Mourning Dove	Ring-necked Pheasant	Tree Squirrel	Jack Rabbit	Cottontails	Dee
---	---	---	---	---	---	---	---	---	---	---	---	---
68.5	72.1	70.6	19.0	7.0	7.0	12.6	77,200	47,400	1,000	42,800	1,800	70
37.7	122.9	7.8	---	---	---	1.9	38,100	13,800	13,300	41,500	2,600	4,00
37.5	45.2	24.6	0.1	---	---	0.6	34,400	6,800	9,900	35,800	1,900	2,80
22.9	43.2	22.6	1.2	---	---	0.6	73,700	1,900	21,200	23,900	15,300	4,00
91.3	16.1	---	---	---	---	---	25,500	5,200	800	500	14,500	---
14.0	58.5	---	---	---	---	16.5	79,300	9,500	700	16,100	---	1,00
---	7.3	9.7	8.7	---	2.0	---	03,400	39,300	1,200	58,400	8,400	---

c. Includes only important species taken by hunters in 1970.
d. No information available.

3

Wildlife [c]				Bloodsucking Arthropods			Occurrence of Zoonotic Disease and Malaria in Area
Tree Squirrel	Jack Rabbit	Cottontails	Deer	Species that occur in Area	Expected increase in Mosquitos & Gnats	Current Mosquito Abatement	
---	---	---	---	d	No	Yes	d
1,000	42,800	1,800	700	d	Yes	Yes	d
13,300	41,500	2,600	4,000	d	Yes	No	d
9,900	35,800	1,900	2,800	d	Yes	Yes	d
21,200	23,900	15,300	4,000	d	Yes	No	d
800	500	14,500	---	d	Yes	No	d
700	16,100	---	1,000	d	Yes	Yes	d
1,200	58,400	8,400	---	d	Yes	Yes	d

ant species taken by hunters in 1970.
able.

III. MAJOR PROBLEM AREA
INFECTIOUS DISEASES-ENTERIC

The infectious enteric diseases considered in this report are described at some length in the following excerpts taken from "Public Health Impacts of Alternative Waste Water Management Concepts, A Report for the U.S. Army Corps of Engineers," by Robert C. Cooper, Ph. D.*

A. Bacterial Diseases

"Bacteria of the genus Salmonella contain a wide variety of species pathogenic for man and animals. These bacterial agents are transmitted from man to man by means of personal contact, contaminated food and contaminated water. There are three clinically distinct forms of Salmonellosis in man: enteric fevers, septicemias and acute gastroenteritis. Typhoid fever caused by Salmonella typhosa is the prototype, and the most severe of enteric fever form of Salmonellosis, and for which man is the only host. At the turn of this century, death rates of more than 50 per 100, 000 persons were not uncommon in cities of the United States. The death rate for the entire country in 1900 was 31. 3 per 100, 000; however, at present it is practically non-existent. Over the last seventy years, the morbidity has also shown significant change; for example, the U. S. morbidity for typhoid fever in 1930 was 12. 6 per 100, 000 and in 1971 there were less than 0. 2 isolations of S. typhosa per 100, 000 population of which less than half were clinical cases. ... The morbidity is getting so low that epidemiologists are beginning to speak in terms of eradication. ... At this point in time in the United States, water is not a significant vehicle for the transmission of this disease.

"The Salmonella septicemias are characterized by bacteremia, high remittent fever usually without involvement of the gastrointestinal tract. These are most commonly caused by S. choleraesuis and are relatively rare. Because the G. I. tract is not normally involved, this clinical type is not usually associated with water and wastewater. Salmonella choleraesuis has a predilection for swine and is not particularly common in the human populations.

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* U.S. Army Corps of Engineers, San Francisco, California, "Alternatives for Managing Wastewater in the San Francisco Bay and Sacramento-San Joaquin Delta Area," Volume II, Appendix C-Assessment of Impacts of Selected Alternatives, July 1971.

"The third form of salmonellosis, acute gastroenteritus, is the form in which the Salmonella are most commonly encountered. In excess of 1400 serotypes have been identified and most, in contrast to S. typhosa, are not host specific. The reported isolation rates from humans in California is between 8.0 and 11.9 per 100,000 and is increasing. The incidence is higher in the Southern portion of the State than in the North. This isolation rate is about the average for the United States as a whole and most health authorities agree is probably much lower than the actual total incidence. An accurate assessment of the number of deaths attributed to Salmonella is not possible but of the recorded cases between 1962 and 1969 the case fatality rate was 0.28 percent, mostly in the very young and very old.

"The most common non-human source of these organisms is food and overwhelmingly poultry products. Water, while an important source, contributes only a little more than two percent of the total .... The most common form of Salmonella isolated from either human or non-human sources in the United States is S. typhimurium. Although the incidence of water-borne salmonellosis is very low, there are a number of occurrences, verified and suspected, in which large numbers of persons infected by this route. One of the most documented is the outbreak in Riverside, California, in 1965, in which 18,000 people were infected with S. typhimurium. ... The bacterium was isolated from 100 different stool specimens and from 5 samples of the drinking water. This report is clear evidence that Salmonella can be transmitted via a municipal water supply.

"Bacteria of the genus Shigella produce an intestinal disease in man and higher apes known as bacillary dysentary. The disease spreads rapidly under conditions of overcrowding and improper sanitation. The mode of transmission is primarily from person to person and through contaminated food. Because these organisms are sensitive to environmental conditions, the water route does not seem to be too important but certainly should not be overlooked. Recently, ... there have been two reports of water-borne outbreaks of Shigellosis in small communities on the East and West Coasts. Both instances involved small common, unchlorinated wells which were obviously contaminated with sewage. Shigella sonnei was isolated in both instances.

"The isolation rate in the United States is approximately 15 per 100,000 population. Of the six species commonly pathogenic for man, S. Sonnei and S. flexneri are most commonly isolated, the former 60.3 percent of the time and the latter 38.2 percent of the time from the various States in the Union."

* * * * *

B. Parasitical Diseases

* * * * *

"In the United States perhaps the most important parasitical disease to be associated with waste water is amoebic dysentary. The etiology of this disease is Entamoeba histolytica, a protozoan, which can infect the human colon causing erosion of the superficial mucous membranes. It may eventually invade the tissue with consequent ulceration. In certain severe cases, the parasite may metastasize to other body organs. The amoeba has the ability to form heavy walled cysts and transmission occurs when mature cysts are excreted with feces into water or food. Infection begins with the ingestion of cysts which germinate in the gut to become vegetative amoeba which multiply and may become invasive. The cysts are most important from an epidemiologic point of view because they are resistant to environmental forces. The vegetative forms do not survive outside the gut. The disease is world-wide and normally occurs in inapparent infections. The incidence of infection in the United States is not well established because of the non-clinical infestations; it is most probably of considerable magnitude."

* * * * *

C. Viral Diseases

"At the present time the viruses considered to be of major importance in waste water are primarily of human origin. These fall into four main groups, the enteroviruses, the adenoviruses, the reoviruses, and the agent of infectious hepatitis. * * *

"All of the enteric viruses are capable of producing clinically obvious diseases; however, with the exception of infectious hepatitis, these manifestations are relatively infrequent complications of otherwise trivial infections.

"The amounts of enteric viruses in sewage have not been precisely established because of the insensitivity and inaccuracy of present detection methods and the variability in the amounts and types of viruses which may be present under different conditions. The enteric virus concentration in domestic sewage reaches a peak during the later summer and early fall and varies with the social-economic level of the population. . . .

"Experimental investigations on the concentrations of enteric viruses in raw sewage indicate that the enteric virus density may range from a few infectious units per 100 ml in cold weather to several hundred in warm weather. . . . Enteric viruses have been isolated from contaminated waters such as marine and estuarine waters, lakes, reservoirs, ground waters, swimming pools and public water supplies."

"Infectious hepatitis is the enteric virus disease of most importance in waste water. Although the agent of infectious hepatitis has not yet been propagated in the laboratory, many outbreaks have been attributed to contaminated water on the basis of epidemiologic evidence. Ten outbreaks have been documented in the United States.... Most of the outbreaks involved gross contamination of small supplies. It has been suggested that there may be many unrecognized infectious hepatitis epidemics.... Although it is a distinct possibility that some of these unrecognized outbreaks are water-borne, the water route still only accounts for less than one percent of the total outbreaks in the United States."

* * * * *

"On the basis of existing evidence, it must be concluded that viral infection resulting from the use of properly treated public water supplies appears to be unlikely at present. A risk of infectious hepatitis arises from the consumption of shellfish taken from sewage-polluted waters. The possibility, however, of either gross viral contamination of raw water sources or the absence or breakdown of reliable treatment procedures at local water treatment plants, poses a constant threat of viruses not being reduced below infectious levels in municipal water supplies."

The important criteria to be considered in evaluating the infectious enteric diseases are as follows: 1) the pathogenic agent, its concentration in the water applied and dose of agent as measured by the rate of application; 2) the population exposed to the agent as determined by the number and age of susceptibles and the means of contact such as by drinking, by recreation or by the consumption of contaminated agricultural products; 3) the method of application of treated water to the land, such as spray or surface irrigation or by injection into the ground; and, 4) the application of residual solids whether by landfill, injection or surface spreading either dry or wet. These criteria are the same for all the infectious enteric diseases.

The information required to make a probability judgment in order of relative importance may be listed:

1. Susceptible population contact: Drinking Water
2. Susceptible population contact: Agriculture
3. Susceptible population contact: Recreation
4. Infectious agent concentration
5. Infectious agent dose
6. Wastewater application method
7. Waste solids application method
8. Size of susceptible population in contact
9. Age distribution of contact population

TABLE IV INFORMATION LIST
Infectious Disease - Enteric

SITE NO	Drinking Water (See Note)	SUSCEPTIBLE POPULATION CONTACT AGRICULTURAL USE: Excluded Area Ac.x 10^{-3}	%	Forest Area Ac.x 10^{-3}	%	Pasture Area Ac.x 10^{-3}	%	Crops Area Ac.x 10^{-3}	%	Infiltration Area Ac.x 10^{-3}	%	Total Acreage Ac.x 10^{-3}	Percent of Crop Area: Rice	Orchard	Truck	RECREATION (Gross Potential Reservoir Visitor Day x 10^{-6})	Infectious Agent Concentration (See Note)
4		No Crops for Human Consumption										11.6	---	---	---	28.10	
5		47.8	14	68.5	19	72.1	20	93.6	27	70.6	20	352.6	7.5	13.5	40.5	109.37	
18		11.1	6	35.7	18	122.9	63	18.7	10	7.8	4	196.2	0	10.1	89.9	254.25	
21		16.8	13	37.5	30	45.2	36	0.9	0.7	24.6	20	125.0	0	66.7	22.2	105.35	
27		42.0	30	22.9	16	43.2	31	10.7	8	22.6	16	141.4	0	0	78.5	120.60	
28		12.3	10	91.3	72	16.1	13	7.2	6	0.0	0	126.9	7.5	13.5	40.5	109.30	
42		14.1	13	14.0	13	58.5	55	20.6	19	0.0	0	107.2	0	80.0	20.0	266.10	
43		5.0	8	0.0	0	7.3	12	40.0	65	9.7	16	62.0	0	0	73.3	265.70	

(Note: No specific Data available - See Comments on Drinking Water, pp. 41-42.)

(Note: As stated in General Assumptions)

2

p Area / l Truck	RECREATION (Gross Potential Reservoir Visitor Day x 10^{-6})	Infectious Agent Concentration (See Note)	INFECTIOUS AGENT DOSE x 10^{-4} 1 Ac/Day: Coliform	Enteric Bacteria	Enteric Virus	WATER APPLICATION Ac. Ft. Per Year x 10^{-3} (1): Forest	Pasture	Crop	Marsh	Total Application	WATER RECOVERED Ac. Ft. Per Year x 10^{-3} (2)
---	28.10		16,500	41	1.7	0.0	0.0	16.2	37.5	53.7	---
40.5	109.37		14,400	36	1.4	354.7	360.5	325.5	234.7	1,275.4	515.2
89.9	254.25		13,200	33	1.3	165.1	469.6	39.3	16.4	690.4	336.2
22.2	105.35		13,200	33	1.3	183.4	153.7	3.7	59.0	399.8	228.5
78.5	120.60		16,700	42	1.6	122.9	219.0	39.5	83.6	465.2	177.6
40.5	109.30		14,400	35	1.4	392.6	49.4	21.6	0.0	464.1	233.1
20.0	266.10		17,200	43	1.7	72.7	297.5	72.1	1.4	443.7	159.8
73.3	265.70		12,800	32	1.3	0.0	35.0	136.0	33.0	204.0	78.6

tated in General Assumptions)

(1) Based on Alternative One as proposed by P.B.Q. & D. Other alternativ would increase application rate on rapid infiltration areas as much as six-fo

(2) Amount of water stored in ground and collected in subdrains.

3

ION ar rsh	Total Application	WATER RECOVERED Ac. Ft. Per Year $\times 10^{-3}$ (2)	ORGANIC WASTE SOLIDS APPLIED Pounds Per Year (Upper and Lower Value)	SIZE OF EXPOSED POPULATION (3) (See Below)	AGE DISTRIBUTION OF CONTACT POPULATION
7.5	53.7	---	437,250 to 1,311,750	169,940	No Data
4.7	1,275.4	515.2	103,444,250 to 310,323,750	93,800	No Data
5.4	690.4	336.2	56,241,875 to 168,725,625	207,200	No Data
9.0	399.8	228.5	32,568,750 to 97,706,250	213,000	No Data
3.6	465.2	177.6	37,896,475 to 113,689,425	250,000	No Data
0.0	464.1	233.1	37,806,875 to 113,420,625	556,800	No Data
.4	443.7	159.8	36,145,000 to 108,435,000	570,900	No Data
3.0	204.0	78.6	16,618,400 to 49,855,200	297,000	No Data

is proposed by P.B.Q. & D. Other alternatives
te on rapid infiltration areas as much as six-fold.
ground and collected in subdrains.

(3) Projected data for specific area not available. Numbers given are based on 1971 census of principal county involved.

SUSCEPTIBLE POPULATION CONTACT: DRINKING WATER

Specific data is not readily available regarding drinking water sources in the various areas. The following are general comments concerning this aspect for each site:

SITE 4 - From the data available there does not seem to be much indigenous drinking water available. Most potable water is probably imported.

SITE 5 - At present the population in the area take their drinking water primarily from wells. Actual sources are not well documented. Ground water is found from 15 to 50 feet below surface. Surface water sources would be Cache Creek and the Sacramento River.

SITE 18 - The area involved is primarily in Marin County and includes a number of small towns whose primary supply is from ground water. General ground water data for most of this area is not available. There may be some potential for drainage into the Nicasio reservoir. Drainage into the Russian River and into Tomales and Bodega Bay is quite probable.

SITE 21 - Little data is readily available as to the sources of drinking water in the site area. It would appear that drinking water is mainly from wells; however, the proximity of much of the area to the Russian River might

indicate that surface water is also used. In areas where ground water data is available, it appears to be relatively close to the surface (area 21.3).

SITE 27 - It would appear that most of this area is not populated and that portion which is is serviced by wells. The Salinas River is involved in drainage area.

SITE 28 - Water is supplied to most of San Mateo County by the San Francisco Water Company. There is no significant ground water in the area chosen. Impingement on Crystal Springs Reservoir is possible although drainage from application area appears to be away from the reservoir.

SITE 42 - Most of this site is on the Marsh Creek water shed which drains into the San Joaquin - Sacramento River delta. Presently there is a low population density served by wells. There are some lakes and ponds. A water supply reservoir is contemplated on Kellogg Creek within the water shed.

SITE 43 - The area involved is in San Joaquin County and is primarily in the river delta area. Local water is from both wells and surface waters. Adjacent communities include Stockton and Tracy.

IV. MAJOR PROBLEM AREA
NON-INFECTIOUS DISEASES - TOXIC CHEMICALS

In considering the possible public health hazard from toxic chemicals in water, the important criteria to assess are the route of significant human exposure to the chemical and the size of the population at risk. The toxic chemicals of concern are those which are not removed by normal treatment processes, accumulate in human tissue after exposure or cause biological effects at low concentrations in water.

Examples of the toxic chemicals which merit special attention are the heavy metal ions, lead and cadmium, and the inorganic anions, nitrate and nitrites, since, historically, episodes of poisoning have been associated with the presence of these compounds in water. The permissible levels for these compounds in public water supplies are tabulated below.

Chemical	mg/liter
lead	0.05
cadmium	0.01
nitrates plus nitrites	10 (as nitrogen)

The route of human exposure to toxic chemicals would be either through drinking water supplies or from consumption of agricultural crops which have been sprayed or irrigated with contaminated water. In the case of nitrates or nitrites drinking water would be the significant route of exposure. Although no translocation of lead or cadmium into food crops has been documented, it would be expected that leafy vegetables such as

lettuce, spinach or even artichokes would retain metal ions sprayed on the leaf surface. It is known, for example, that the lead content of grass growing near freeways and exposed to automobile exhaust has levels of up to several thousand parts per million. Rice plants may also retain significant levels of cadmium since farmers in the Jintsu area of Japan who suffered from cadmium poisoning, used water contaminated with cadmium, lead and zinc to irrigate their rice crops.

Classes of chemicals not considered significantly hazardous to health but that could appear in small quantities in the treated water include: the chlorinated hydrocarbon insecticides of the DDT-type, the organophosphate pesticides, the chlorinated phenoxyacetic acid type of herbicide, phenols, carbon-chloroform extract, and trace elements such as manganese, fluorides, zinc, arsenic and selenium. It is likely that dietary intake of pesticides, zinc, fluoride, arsenic, and selenium will far outweigh any significant intake from treated water. The nuisance threshold of phenols (odor) and manganese (discoloration of laundry) is much lower than the threshold for adverse health effects. It is therefore highly improbable that the presence of small quantities of these chemicals in treated water will significantly affect health.

INFORMATION LIST
NON-INFECTIOUS DISEASES-TOXIC CHEMICALS

1. Size of population at risk:

Because of lack of a specific area census or census projection, the present census of the primary county of each site formed the essential basis for evaluation. (See Table V.)

2. Route of significant human exposure:

a) Drinking Water - Information was sparse on drinking water sources at selected sites, but estimates of their possible contact with waste water disposed are listed in Table V.

b) Rice and Truck Crops - Agricultural acreage in contact with disposed waste water was calculated in accordance with Alternative Application Plan No. 1. Results are listed by site in Table V.

TABLE V.

SITE NO.	Population x 10^{-3}	Rice and Truck Acreage x 10^{-3}	Probability of Contact with Drinking Water*
4	10w	0.0	1 +
5	94	45.0	2 +
18	207	16.8	3 +
21	213	0.2	3 +
27	10w	8.4	2 +
28	557	7.2	2 +
42	580	5.2	3 +
43	300	29.0	3 +

* Sites are rated in relation to each other as to probability of contact with drinking water on a scale where 1 = lowest probability of contact and 4 = highest probability of contact.

NOTE: Lacking any population projections for these sites and having very little information on actual drinking water sources in these areas, the conclusions reached in the above table are perforce tenuous ones.

APPENDIX II

EVALUATION FORMS

Initial questionnaire to be filled out by each consultant.

Probability Rating Sheet used by each consultant for the problems in his area of expertise.

Sample Calculation.

SUBJECTIVE PROBABILITY
THAT
INCIDENCE OF PROBLEM
WILL
INCREASE AT EACH SITE

____

By ______________________________

Date ______________________________

Probability is 0.0		Probability is 1.0
SITE # 4	______________________________	
SITE # 5	______________________________	
SITE # 18	______________________________	
SITE # 21	______________________________	
SITE # 27	______________________________	
SITE # 28	______________________________	
SITE # 42	______________________________	
SITE # 43	______________________________	

ESTIMATES TO USE IN RELATING PROBLEMS TO EACH OTHER

Problem 0.0		1.0
SITE #	______________________________	
SITE #	______________________________	
SITE #	______________________________	

INFORMATION NEEDED TO MAKE
PROBABILITY ESTIMATES FOR
PUBLIC HEALTH PROBLEM:__________________

You will be asked to estimate the probability that the incidence of ____________________ will increase above its current incidence rate at a disposal site for waste water in the San Francisco Bay-Delta Central Valley area. In order to help you to make that probability estimate, we would like to obtain for you the information you need and summarize it for each of eight sites. Please indicate below, in any order you wish, the information (data, description, etc.) you feel you need about a disposal site to make the probability estimate that the incidence of ____________________ will increase above its current level.

1.

2.

3.

4.

5.

6.

7.

8.

(If you do not have room to list all of your requirements on this sheet, continue your list on another sheet of paper and attach it to this one.)

Since we may not be able to obtain all of the information you have requested, please rank order the importance of the pieces of information you have listed, assigning "1" to the most important piece of information necessary for you to make a probability estimate, "2" to the next most important, "3" to the next, etc.

If we cannot obtain the piece of information you have ranked as least important, could you still make a judgment of the probability that the incidence of ____________________ will increase? (Yes or No)

Sample Calculation for Site i = 5

j	Medical Problem	S_j	P_{5j}	S_jP_{5j}
1	Rabies	100	.25	25.00
2	Enteric virus polio	100	.08	8.00
3	Plague	87	.23	20.01
4	Coccidioidomycosis (blacks)	83	.98	81.34
5	Infectious hepatitis	83	.09	7.47
6	Encephalitis	52	.98	50.96
7	Typhoid	49	.08	3.92
8	Heavy metal effects: lead and zinc/cadmium	47	.21	9.87
9	Murine typhus fever	42	.04	1.68
10	Other salmonella	39	.08	3.12
11	Parasitical: E. hystolytica	33	.02	.66
12	Coccidioidomycosis (whites)	24	.98	23.52
13	Shigella	21	.08	1.68
14	Nitrates effect	20	.00	.00
15	Malaria	17	.20	3.40
16	Tularemia	15	.75	11.25
17	Leptospirosis	14	.47	6.58
18	Nuisance: pasture mosquitoes	7	.99	6.93
19	Enteric virus: adeno	4	.08	.32
20	Nuisance: biting flies	4	.99	3.96
21	Enteric virus: echo	0	.08	.00
22	Nuisance: rodents	0	.73	.00
23	Nuisance: odors	0	.00	.00
	TOTAL	841		269.67

$$S_5 = \Sigma S_jP_{5j} / \Sigma S_j = 269.67/841 = .32$$